Active Combustion Control Valve, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

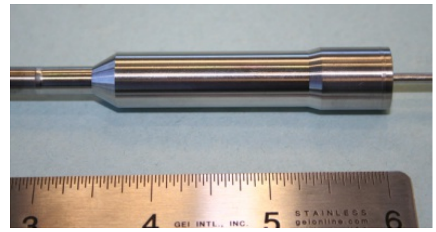
ABSTRACT

Over the past decade, research into active combustion control has yielded impressive results in suppressing thermoacoustic instabilities and widening the operational range of gas-turbine combustors. Active Combustion Instability Control (ACIC) controls the combustion process such that the heat release profile is modulated to dampen the naturally occurring thermoacoustic instabilities. A major challenge to effective implementation of active combustion control is the availability of valves and actuators that provide adequate flow modulation control authority. The majority of the published work revolves around valves designed to modulate the main combustor flow. At present these valves are not designed to operate in a harsh environment and as such are required to be located outside the main flow path, reducing their control authority. To effectively meet the challenge, valves and sensors that are smaller, more responsive and robust must be developed. Ultimately the control valves are co-located with the fuel injection manifold. The trade-off for the harsh environment operation is the ability to maximize the flow modulation control authority. The objective of this research is to integrate the required control authority into an operational environment. This research continues the development of a light weight fast-acting fuel control valve for harsh environment operation. In the Phase 1 effort, the valve demonstrated the ability to modulate fluid flow at 1,000 Hz. This demonstrated the valve will allow the precise time dependent fuel control required for lean-burn combustor operability. In this Phase II research a Prototype valve is designed, fabricated and flow tested using commercially-available driver circuitry to demonstrate valve operation in harsh thermal environments.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: Potential NASA applications include those application where a valve can cycle at



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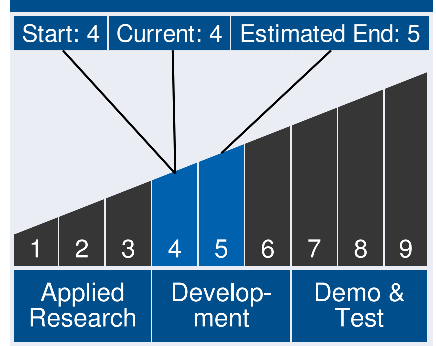
Technology Maturity



Management Team

Program Executives:
- Joseph Grant
- Laguduva Kubendran

Program Manager:
- Carlos Torrez

Continued on following page.

high frequencies. These applications include liquid rocket engine combustion stability control, where the principles being applied to combustion control for gas turbine engines can be applied. In this application, the ability to modulate the propellant flow at frequencies above 1,000 Hz may be advantageous. A second potential application is in high frequency valves for pulsing space engines such as the Pulse Inductive Thrusters. These units require valves that operate a flow rates and pulse frequencies similar to the current ACCV. In addition they require very long life, as these low force thrusters operate for very long periods of time. The effort being proposed will provide solutions that are applicable to both of these applications.

To the commercial space industry:

Potential Non-NASA Commercial Applications: The valve has a direct application to active combustion control in gas turbines. The valve allows precise time dependent fuel control required for lean-burn combustor operability. The small size, internal cooling capability and high frequency modulation capability of 1,000 Hz makes it directly applicable for use in this application. The benefit of harsh environment operation is the ability to maximize the flow modulation control authority due to close proximity to the fuel injector. The valve also has application to combustion stability control in commercial liquid fueled rocket engines. Using active combustion control in rocket engines has the potential to save millions of dollars in development costs and reduce development schedules

Management Team *(cont.)*

Project Manager:

- Joseph Saus

Principal Investigator:

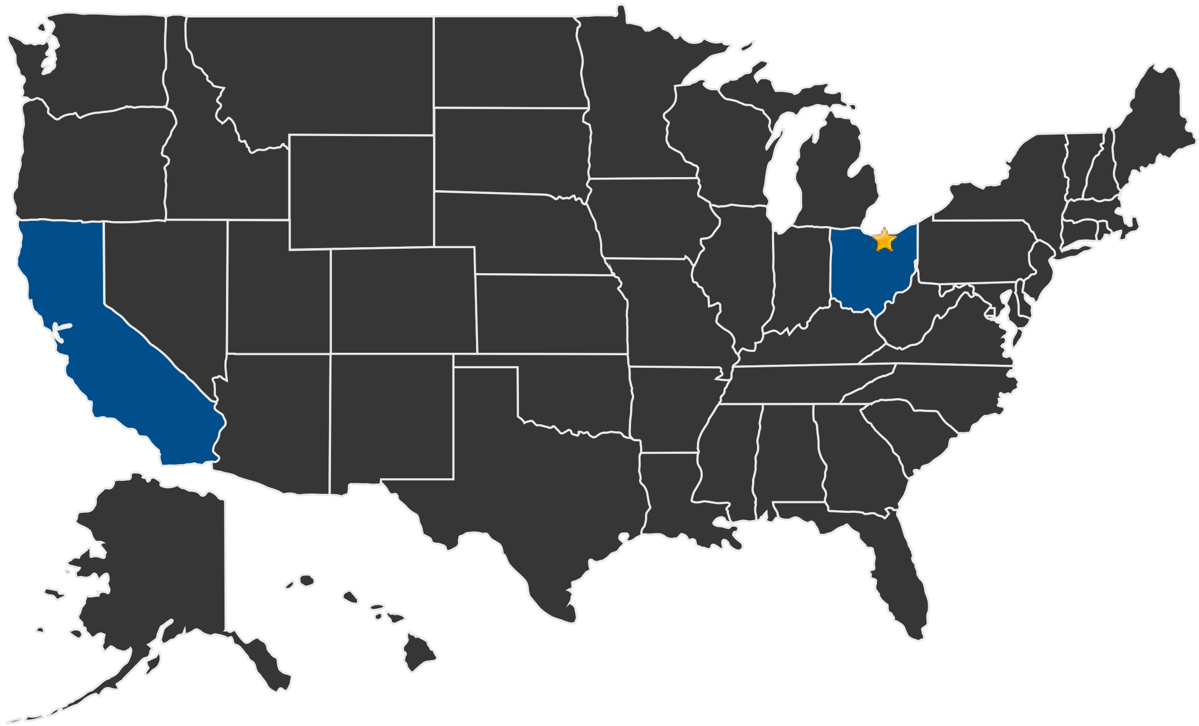
- Wendel Burkhardt

Technology Areas

Primary Technology Area:

Aeronautics (TA 15)
- Ultra-Efficient Commercial Vehicles (TA 15.3)
  - Achieve Community Goals for Improved Vehicle Efficiency and Environmental Performance Beyond 2035 (TA 15.3.3)
    - Enable Low Nitrogen Oxides (NOx) Fuel Flex Combustor – Propulsion (TA 15.3.3.6)

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Glenn Research Center

Other Organizations Performing Work:

- WASK Engineering, Inc. (Cameron Park, CA)

PROJECT LIBRARY

Additional Images

- Briefing Chart Image
    - (This image is a .tif file. Please visit http://techport.nasa.gov:80/file/21939 to download this image to view it.)

Presentations

- Briefing Chart
    - (http://techport.nasa.gov:80/file/23067)
- Final Summary Chart
    - (http://techport.nasa.gov:80/file/23805)

DETAILS FOR TECHNOLOGY 1

Technology Title

Active Combustion Control Valve

Potential Applications

Potential NASA applications include those application where a valve can cycle at high frequencies. These applications include liquid rocket engine combustion stability control, where the principles being applied to combustion control for gas turbine engines can be applied. In this application, the ability to modulate the propellant flow at frequencies above 1,000 Hz may be advantageous. A second potential application is in high frequency valves for pulsing space engines such as the Pulse Inductive Thrusters. These units require valves that operate a flow rates and pulse frequencies similar to the current ACCV. In addition they require very long life, as these low force thrusters operate for very long periods of time. The effort being proposed will provide solutions that are applicable to both of these applications.